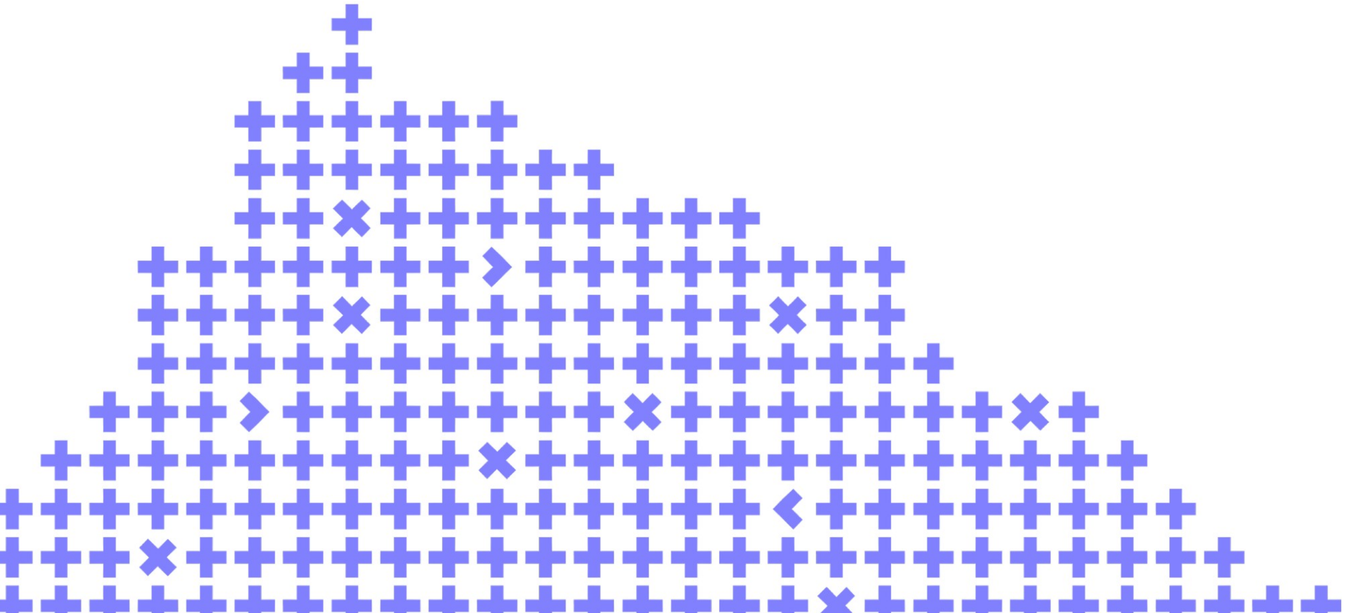
Transactional Queues in PostgreSQL

Igor Loban



Title

- Body Level One
  - Body Level Two
    - Body Level Three
      - Body Level Four
        - Body Level Five

- 10 years in backend
- The last 6 years at Toloka.ai
- Lover of Java and PostgreSQL

About Toloka.ai

- Toloka is a data labeling service for ML
- 300 labels per second from real people
- 40 microservices
- Many clusters of PostgreSQL, MongoDB, ClickHouse, Redis
- SQS-like message brokers for async communication

About Toloka.ai

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Goal

- Highlight the problem that forces to use transactional queues in PostgreSQL
- Give a foundation to solve that problem in your projects

- Body Level One
  - Body Level Two
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Content

01

Why should we use transactional queues?

Problem

- Distributed business transactions
- also known as consistent changes in different services

- Body Level One
  - Body Level Two
    - Body Level Three
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Problem

- Distributed business transactions
- also known as consistent changes in different services
- Saga pattern is one of the solutions
- The main challenge is **an atomic change in a local DB and sending a message to a broker**

- Body Level One
  - Body Level Two
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Example 1

- Body Level One
  - Body Level Two
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        - Body Level Five

```
@Transactional
public void updateOrder(Order order) {
  // transaction has been started
  orderRepo.save(order);

  writeToExternalQueue(order);

  // commit can fail!

}
```

Example 2

```
public void updateOrder(Order order) {
    saveOrderInTx(order); // DB transaction inside the method
    writeToExternalQueue(order); // can fail!
}
```

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Solution

- Background process for retries
- Boolean field “sent to queue” in an entity

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Solution

- Background process for retries
- Boolean field “sent to queue” in an entity
- Problem 1: potential performance degradation
- Problem 2: similar code in multiple places

- Body Level One
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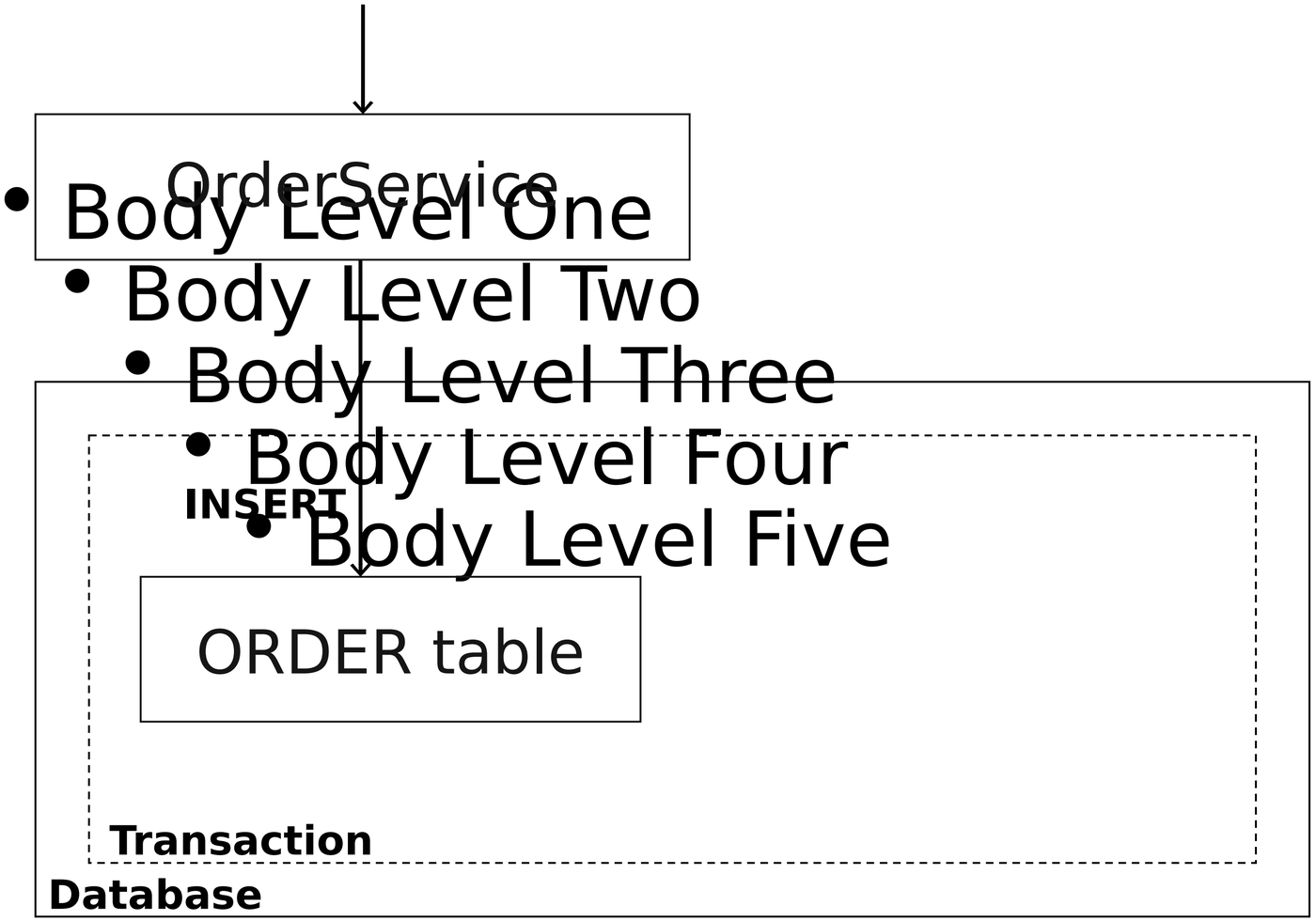
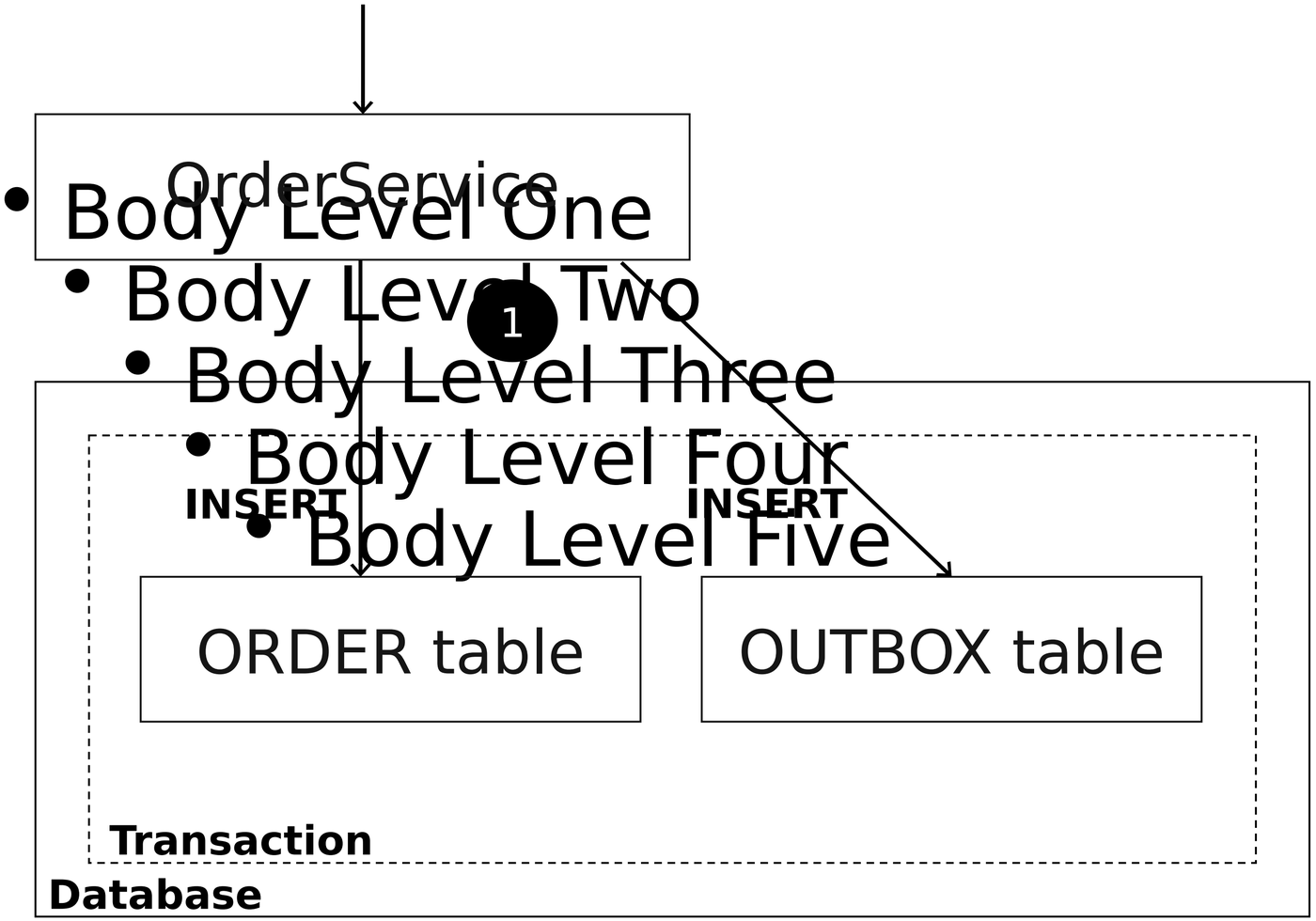
02

Transactional Outbox Design Pattern

Transactional Outbox



Transactional Outbox



Transactional Outbox

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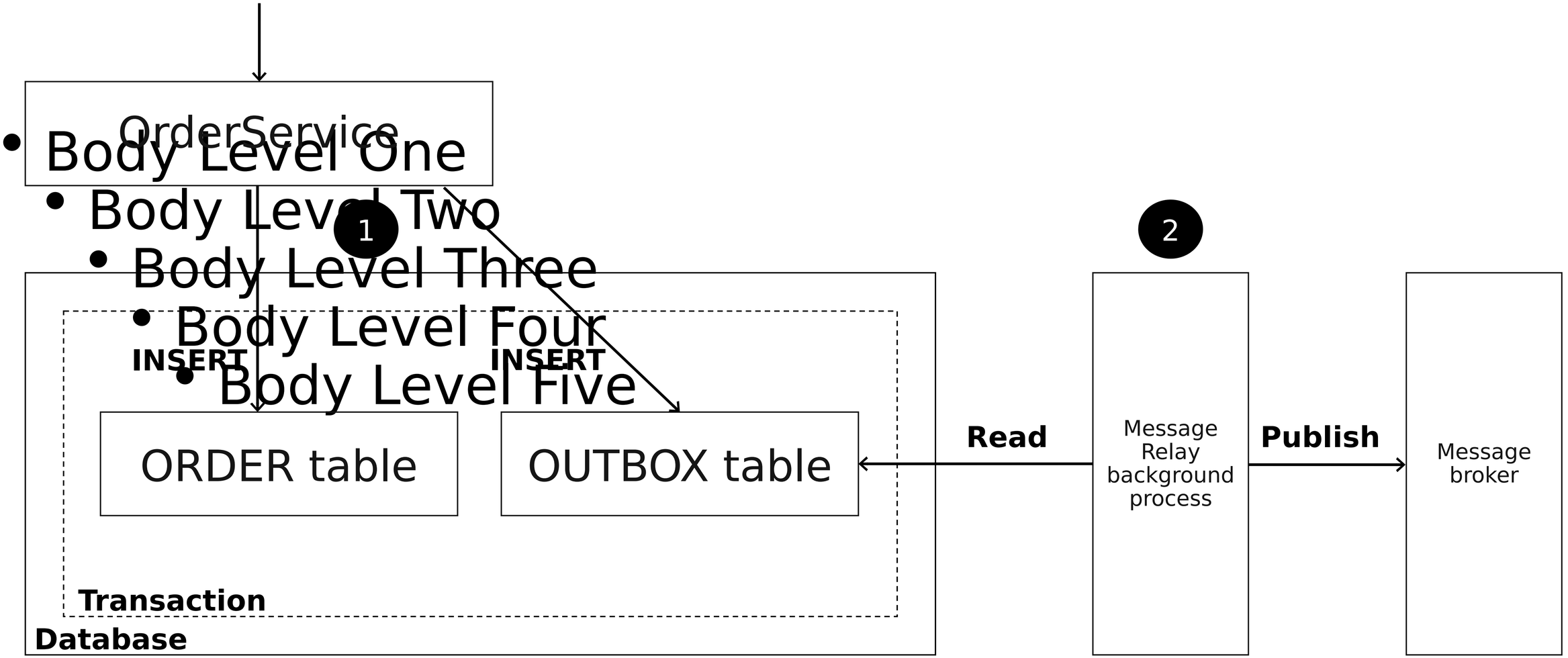

Transactional Outbox Subtypes

- Body Level One
  - Body Level Two
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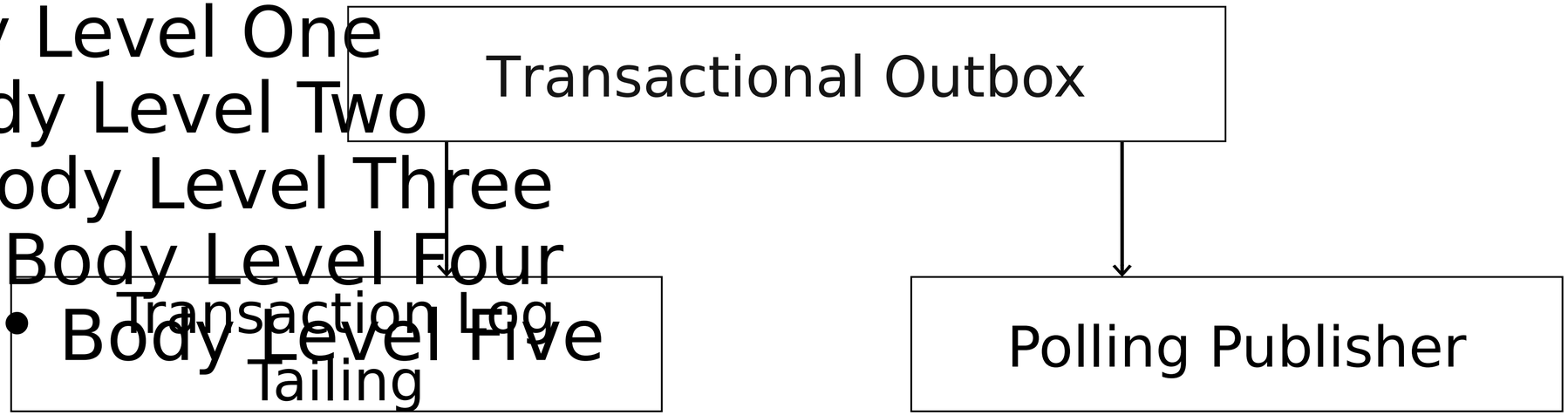

Transaction Log Tailing

- Body Level One
  - Body Level Two
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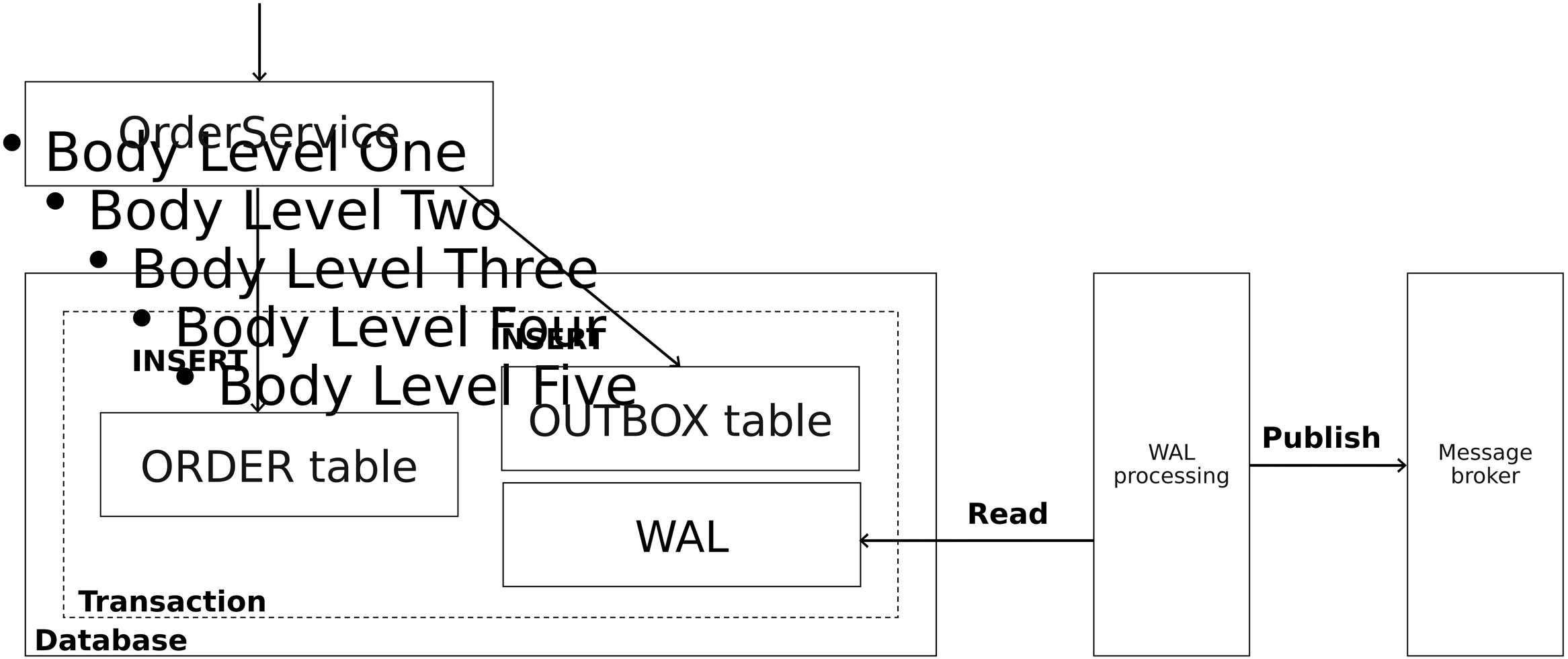
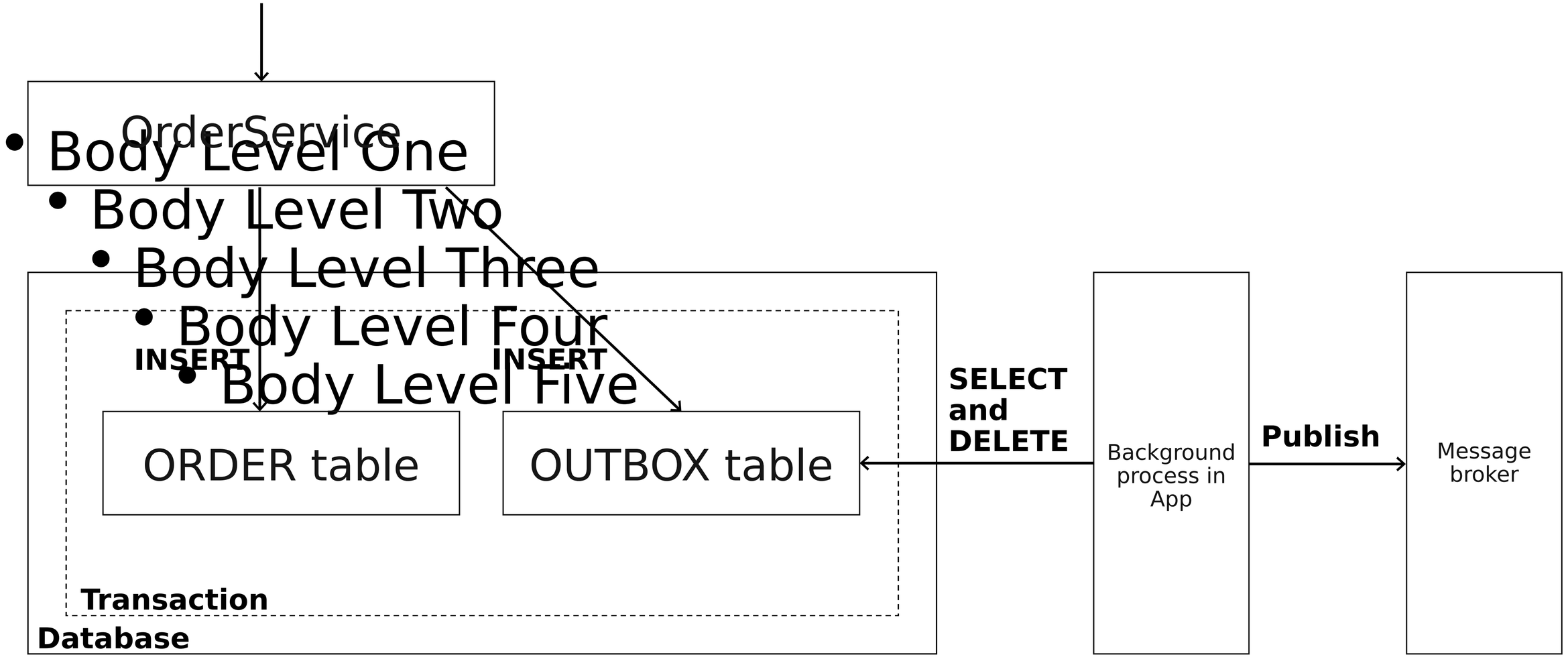


Polling Publisher



Long DB Transactions

- Business logic of your application
- Queries to an analytic replica (hot_standby_feedback)
- Index building
- pg_repack

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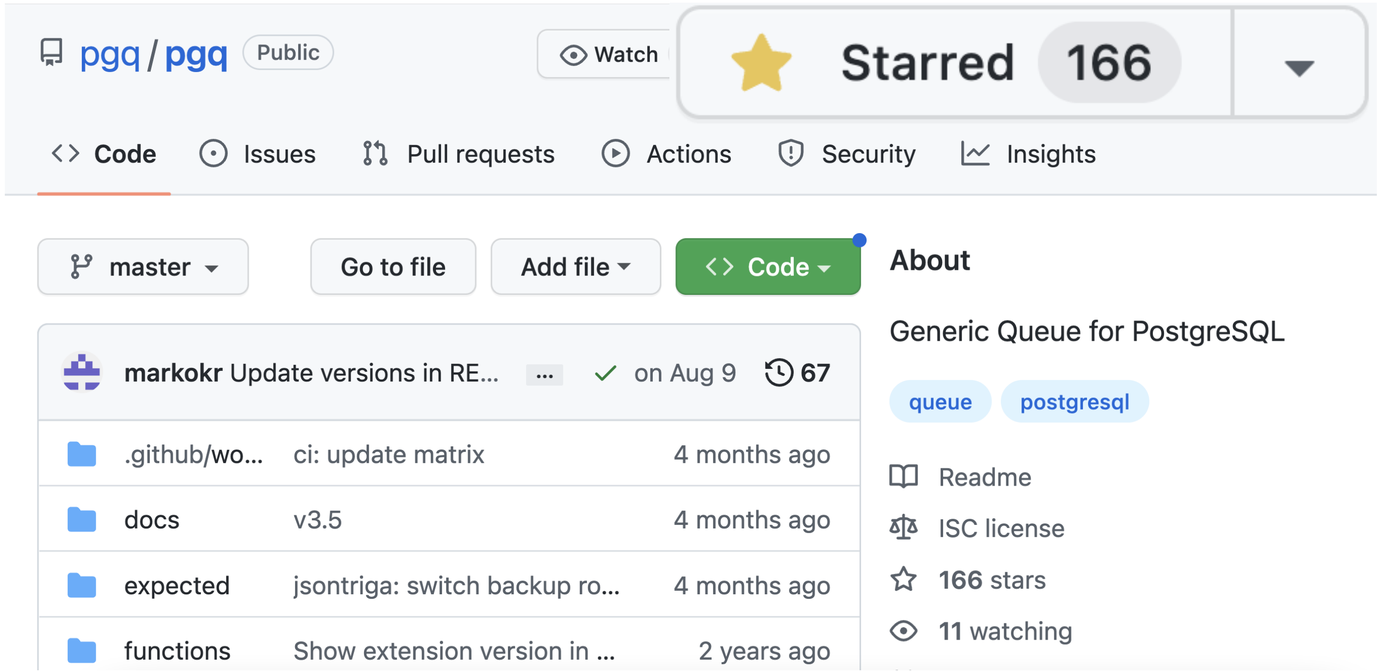
03

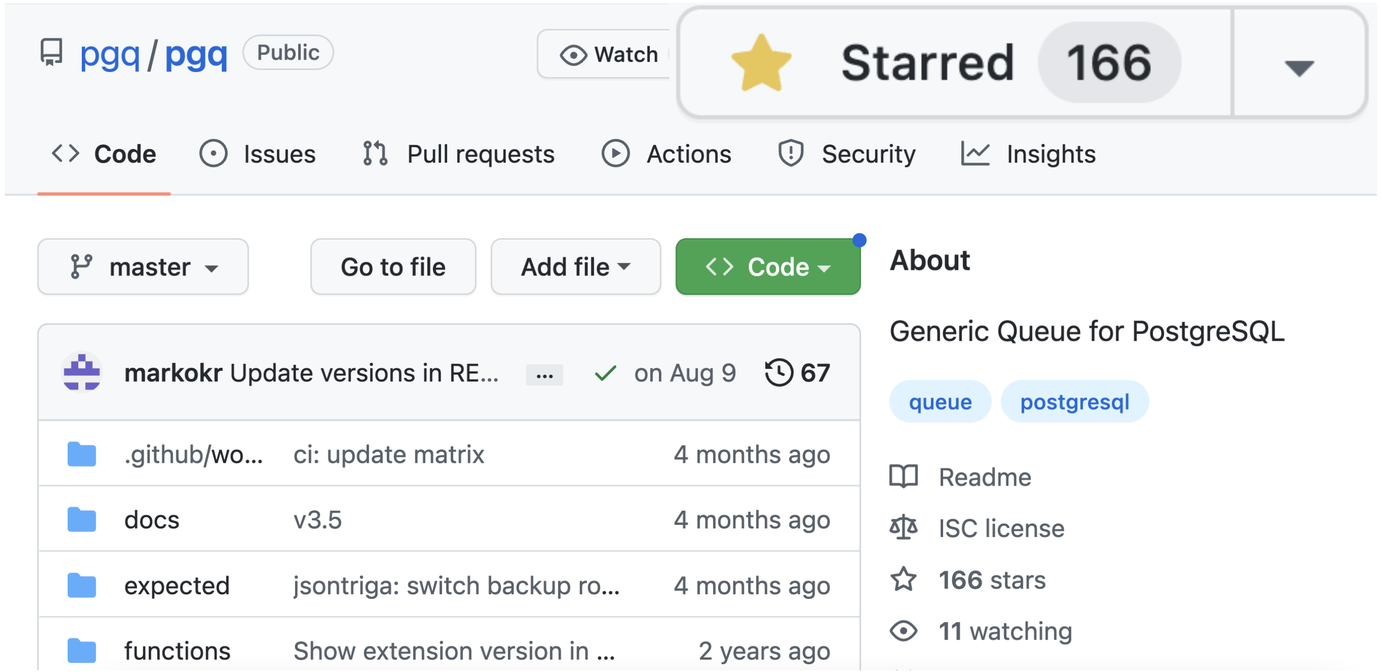
PgQ and Eventuate

PgQ



- Extension for PostgreSQL
- Full-fledged message broker based on PostgreSQL
- Requires process-daemon pgqd

PgQ



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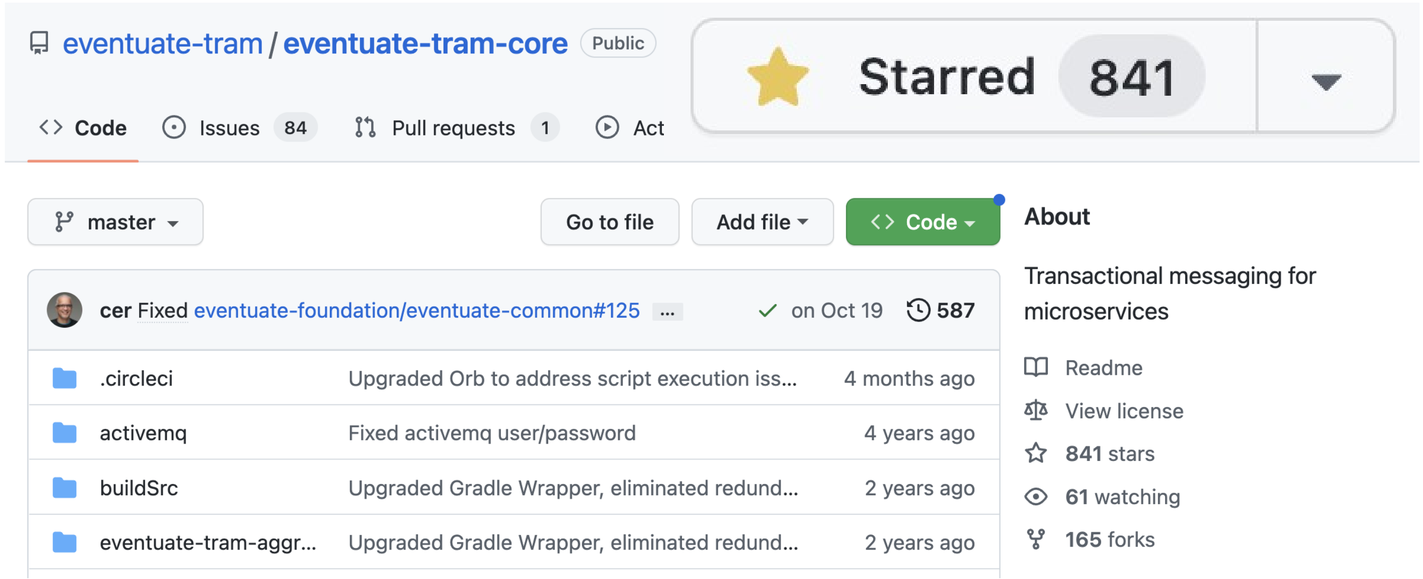
Eventuate



- Framework for Transactional Outbox and Saga patterns
- PostgreSQL and MySQL – Transaction Log Tailing
- SQL Server – Polling Publisher

04

Recipe for Transactional Queues in PostgreSQL

Limitations

- Body Level One
  - Body Level Two
    - Body Level Three
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        - Body Level Five

At-least-once delivery

No ordering guarantee

Stress-test

- Disclaimer: it is not a benchmark
- 70 writers (1000 events per second)
- 5 readers (2000 events per second)
- Sync replica with 50 ms delay (recovery_min_apply_delay)
- Begin a long transaction and wait for 5 min

- Body Level One
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Title FOR UPDATE

The OUTBOX table

- Body Level One
  - Body Level Two
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```
CREATE TABLE queue_buffer (
  id      BIGSERIAL PRIMARY KEY,
  payload TEXT
);
```

Title FOR UPDATE

Readers lock rows, sleep, and delete them in a single transaction

- Body Level One
  - Body Level Two
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```
BEGIN;

SELECT id, payload FROM queue_buffer

ORDER BY id

FOR UPDATE

LIMIT ?;

…

DELETE FROM queue_buffer WHERE id IN (…);

COMMIT;
```

Title FOR UPDATE

- Body Level One
  - Body Level Two
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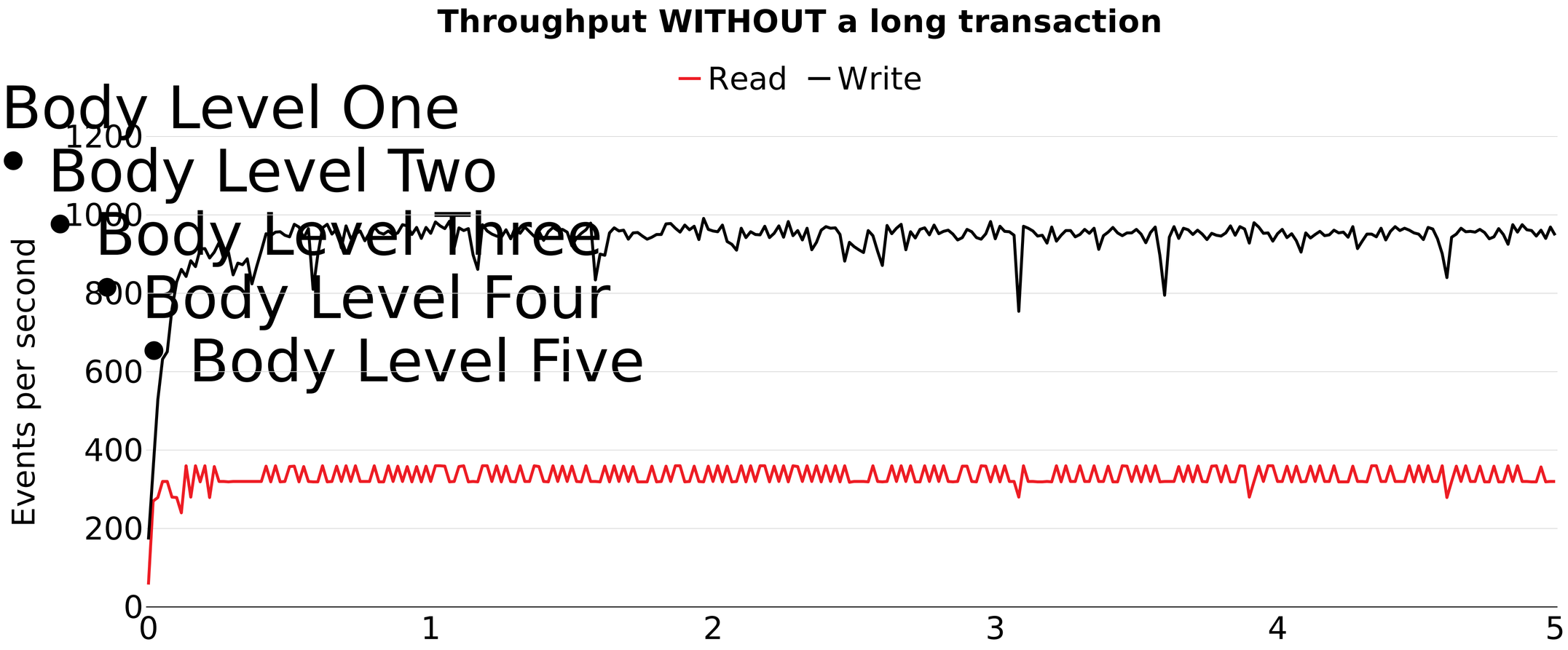

Title FOR UPDATE

- Body Level One
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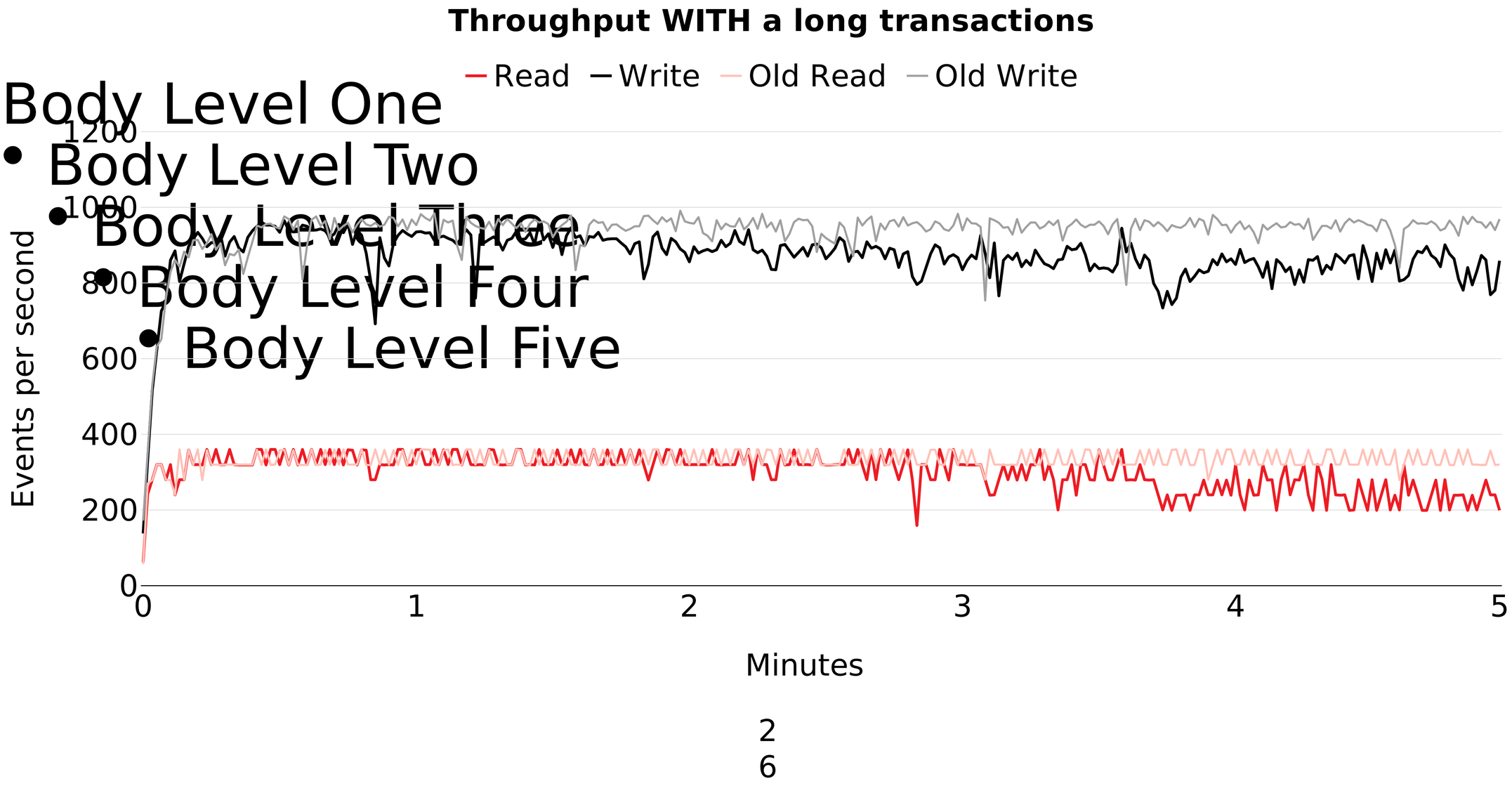

Zitsa SKIP LOCKED

- Body Level One
  - Body Level Two
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- SELECT ... FOR UPDATE **SKIP LOCKED**
- The reader concurrency problem is solved
- No order guarantee

SKIP LOCKED

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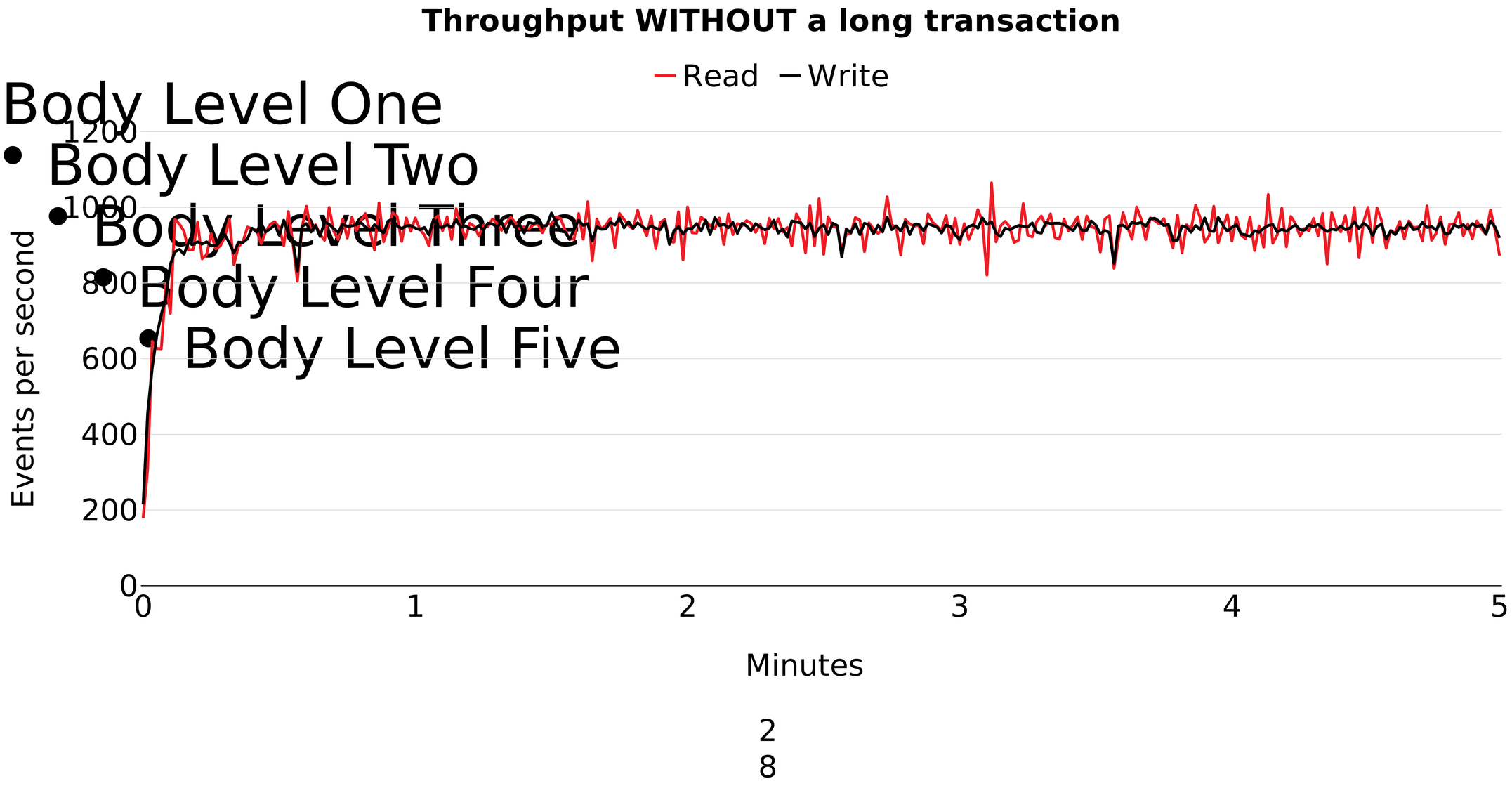

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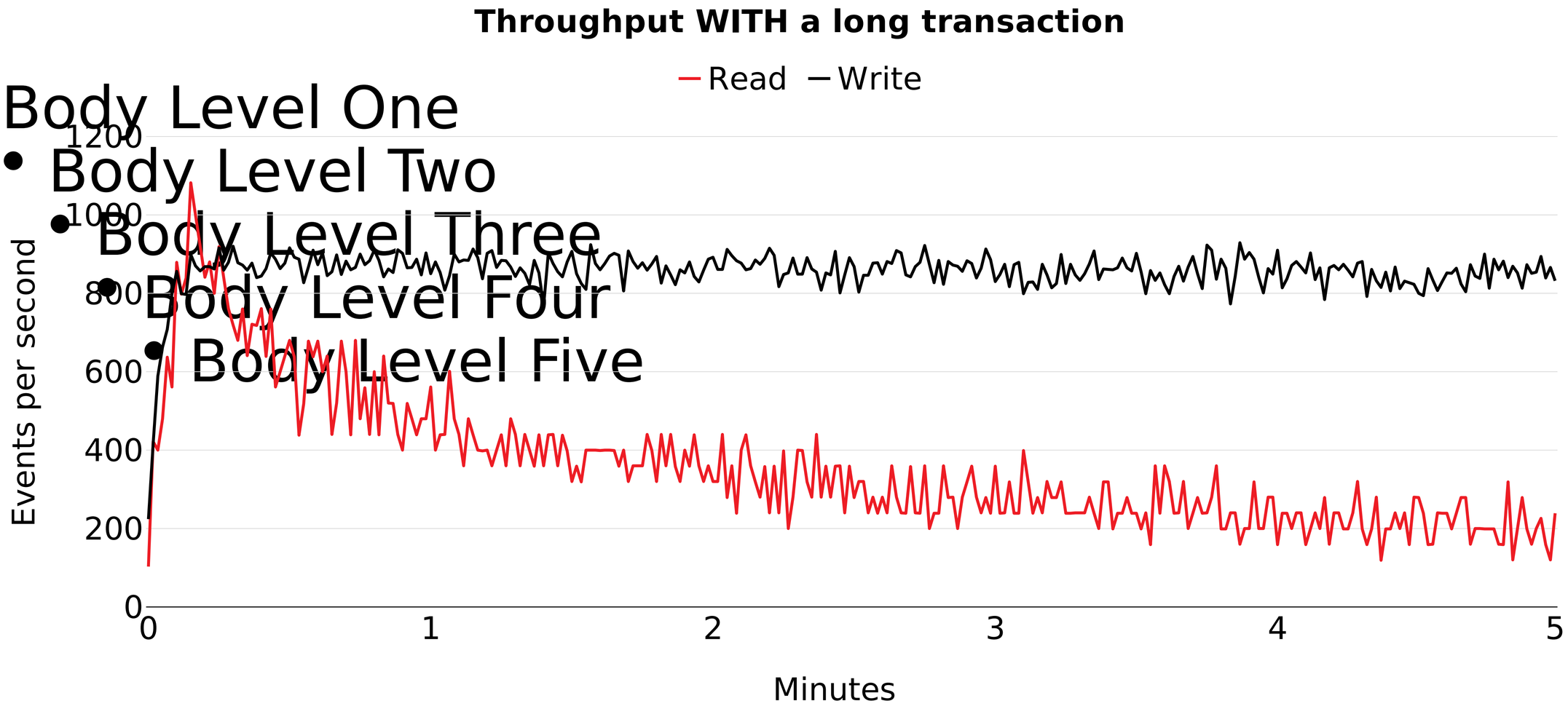

Bitwise WHERE id > :prev_id

- SELECT ... **WHERE id > :prev_id** ... FOR UPDATE SKIP LOCKED
- prev_id is the last processed ID
- Every 10th query will reset prev_id

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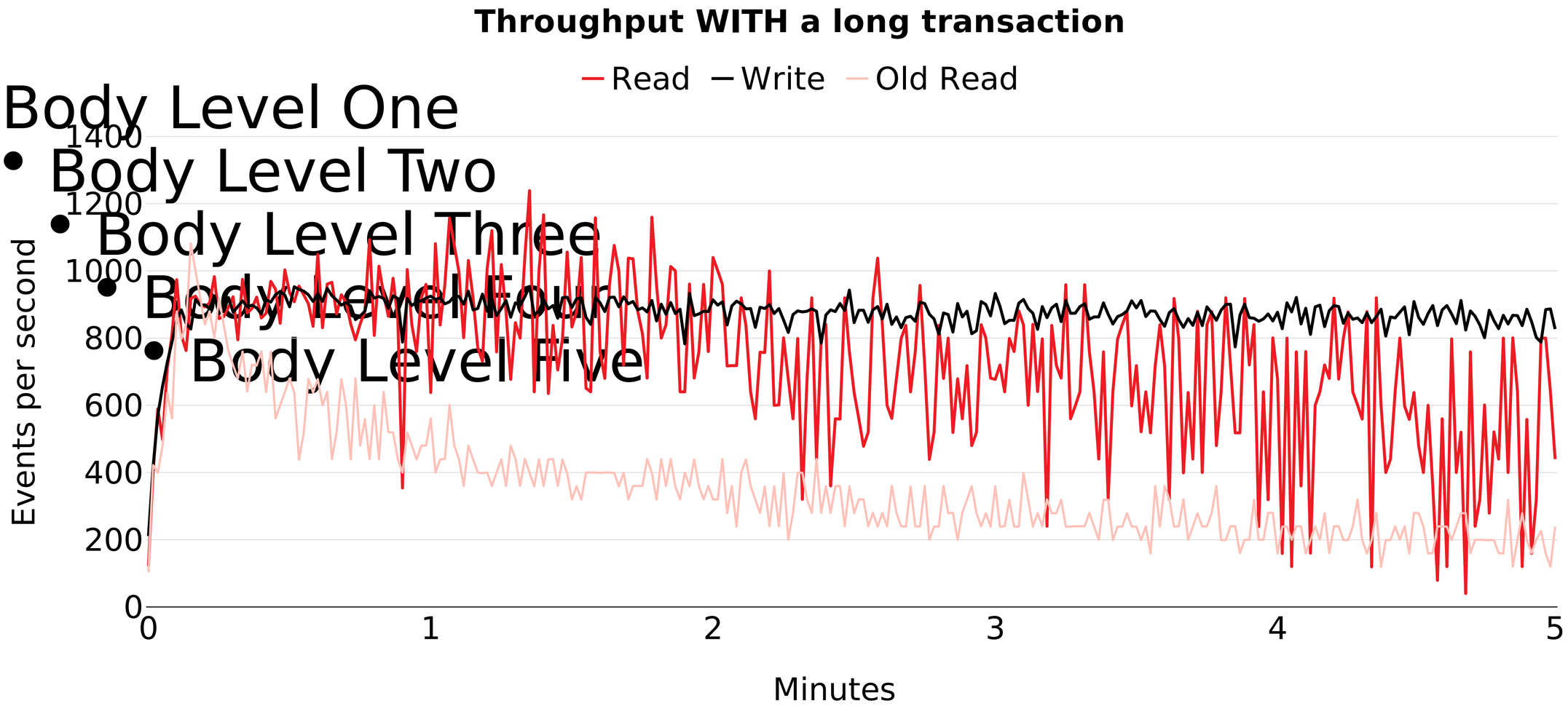

Title
SET LOCAL synchronous_commit TO OFF

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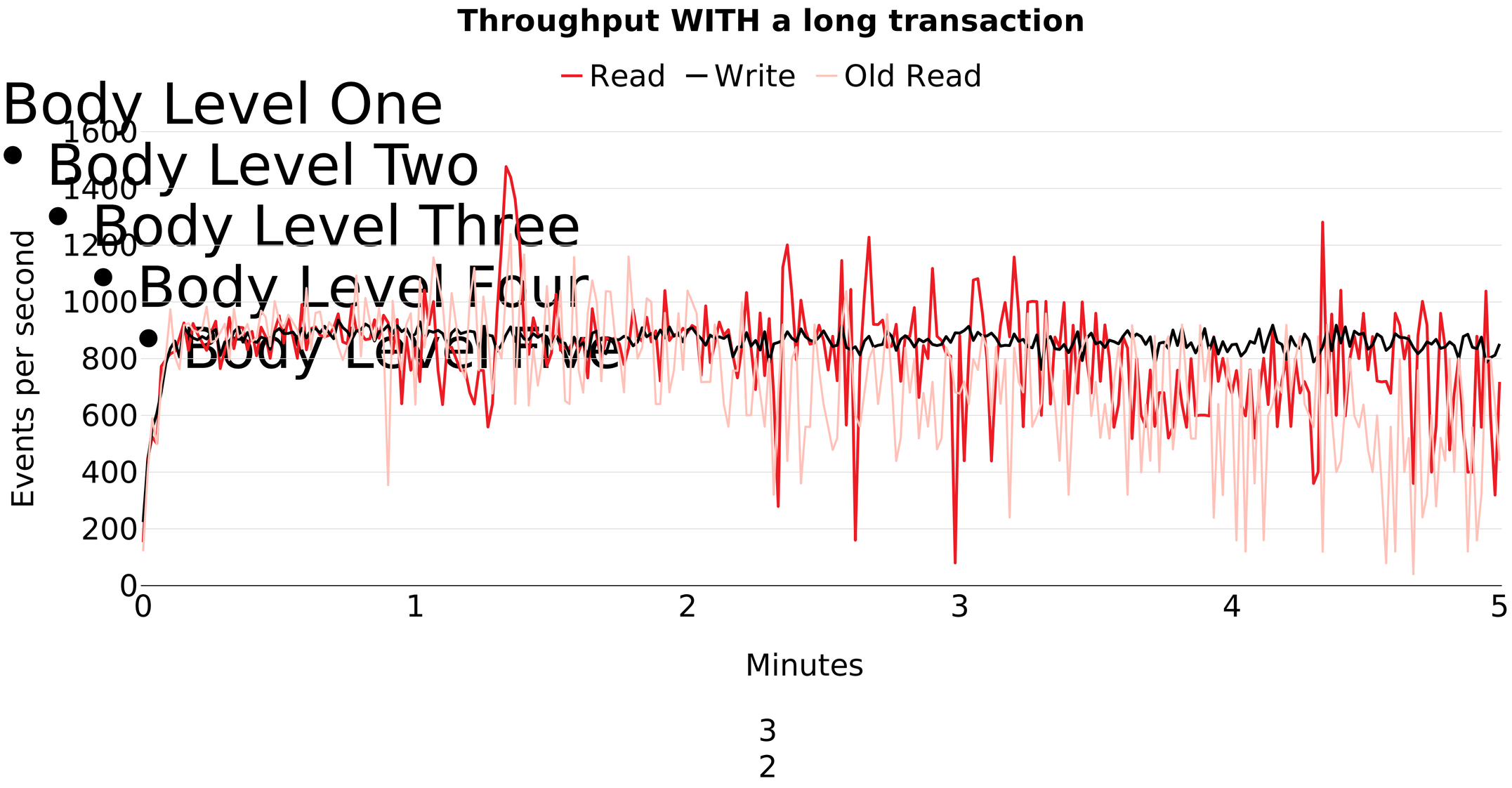

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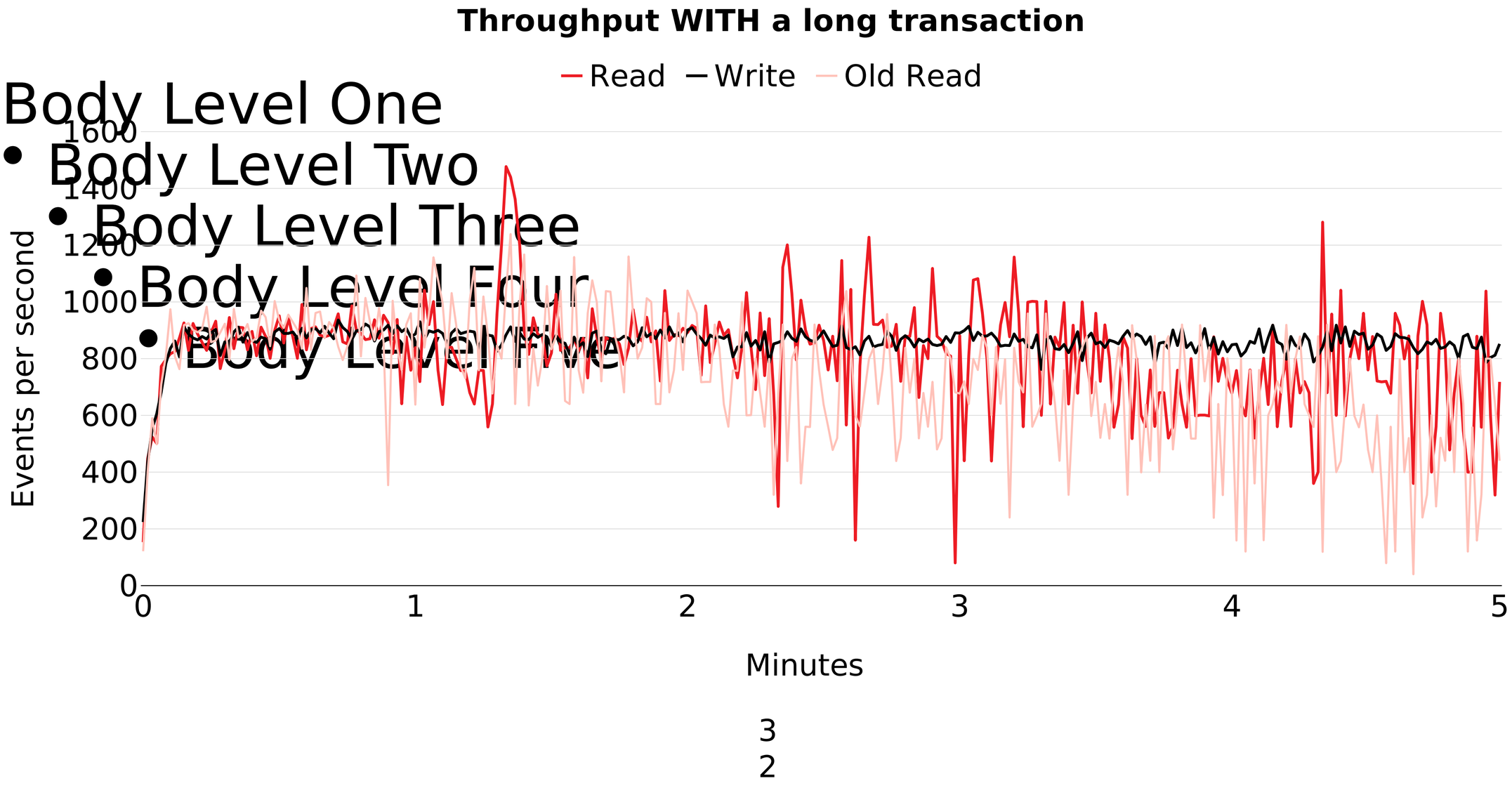

Title TRUNCATE

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- TRUNCATE is not MVCC safe
- Three queue_buffer tables instead of one
- Run TRUNCATE every 10 seconds

Title TRUNCATE

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Title TRUNCATE

Writers will insert a message, if they can take a shared lock. N = 1, 2, 3

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```
BEGIN;
SELECT pg_try_advisory_xact_lock_shared(N);
INSERT INTO queue_buffer_N (payload) values (?);
COMMIT;
```

Title TRUNCATE

The TRUNCATE background process. N = 1, 2, 3

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```
BEGIN;
SET LOCAL lock_timeout = '30s'; SET LOCAL statement_timeout = '30s';
SELECT pg_advisory_xact_lock(N);
LOCK TABLE queue_buffer_N IN ACCESS EXCLUSIVE MODE;
CREATE TEMPORARY TABLE queue_buffer_N_copy ON COMMIT DROP AS SELECT * FROM queue_buffer_N
WITH DATA;
TRUNCATE queue_buffer_N;
INSERT INTO queue_buffer_N SELECT * FROM queue_buffer_N_copy;
COMMIT;
```

Title TRUNCATE

- Body Level One
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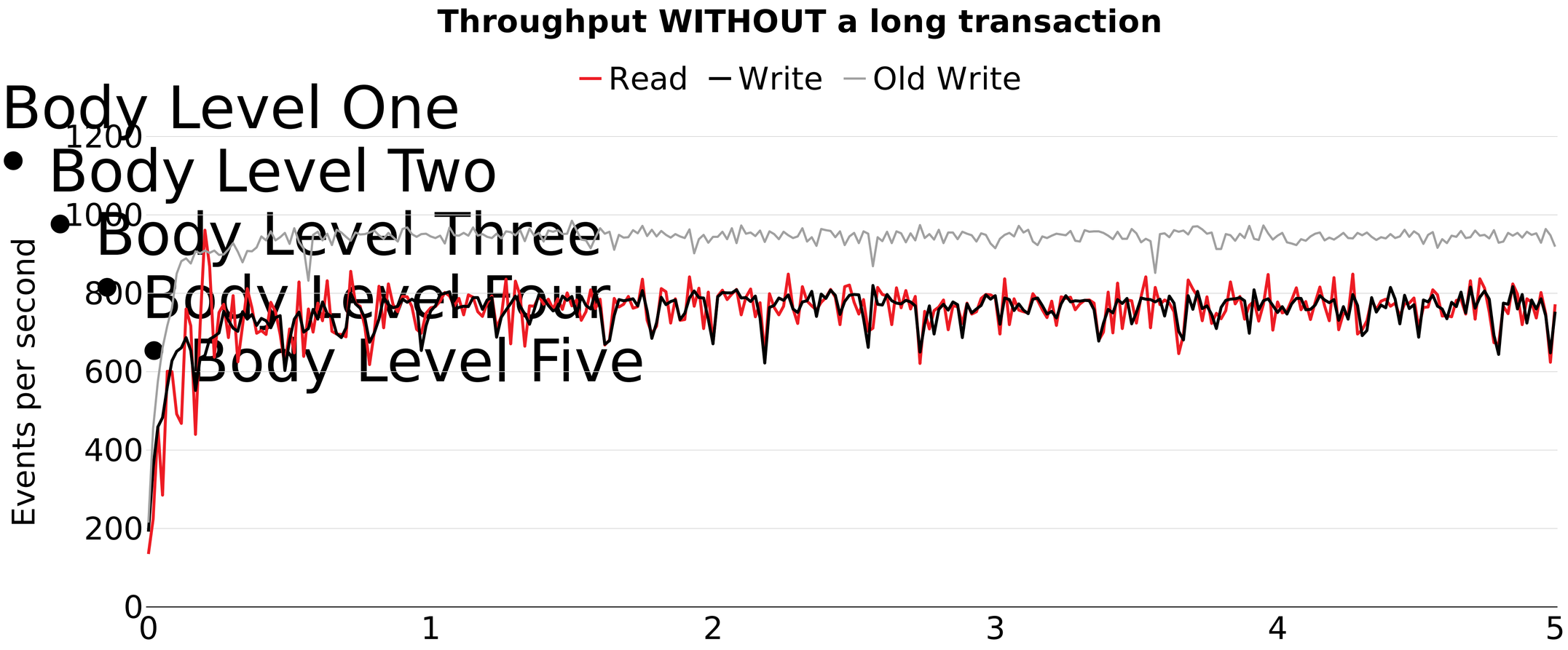

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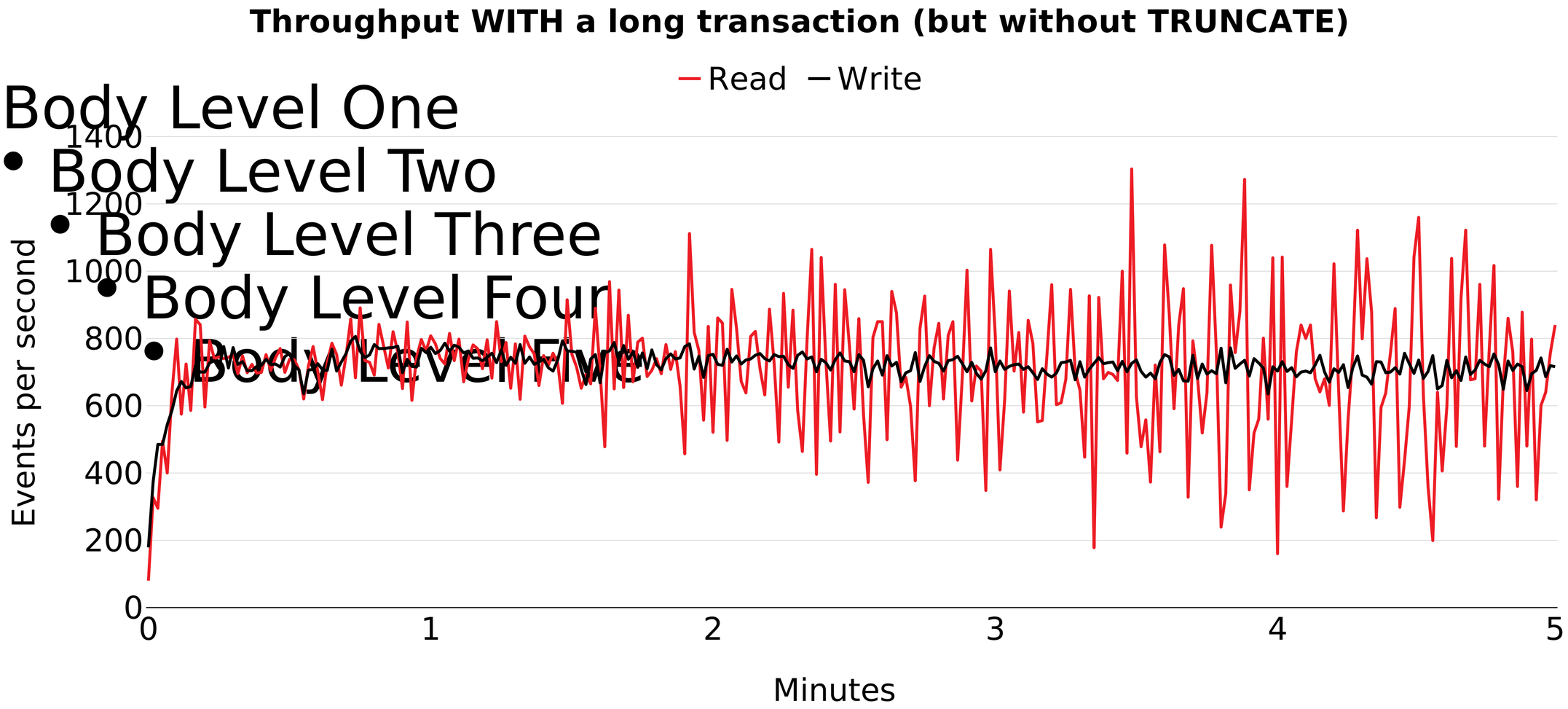

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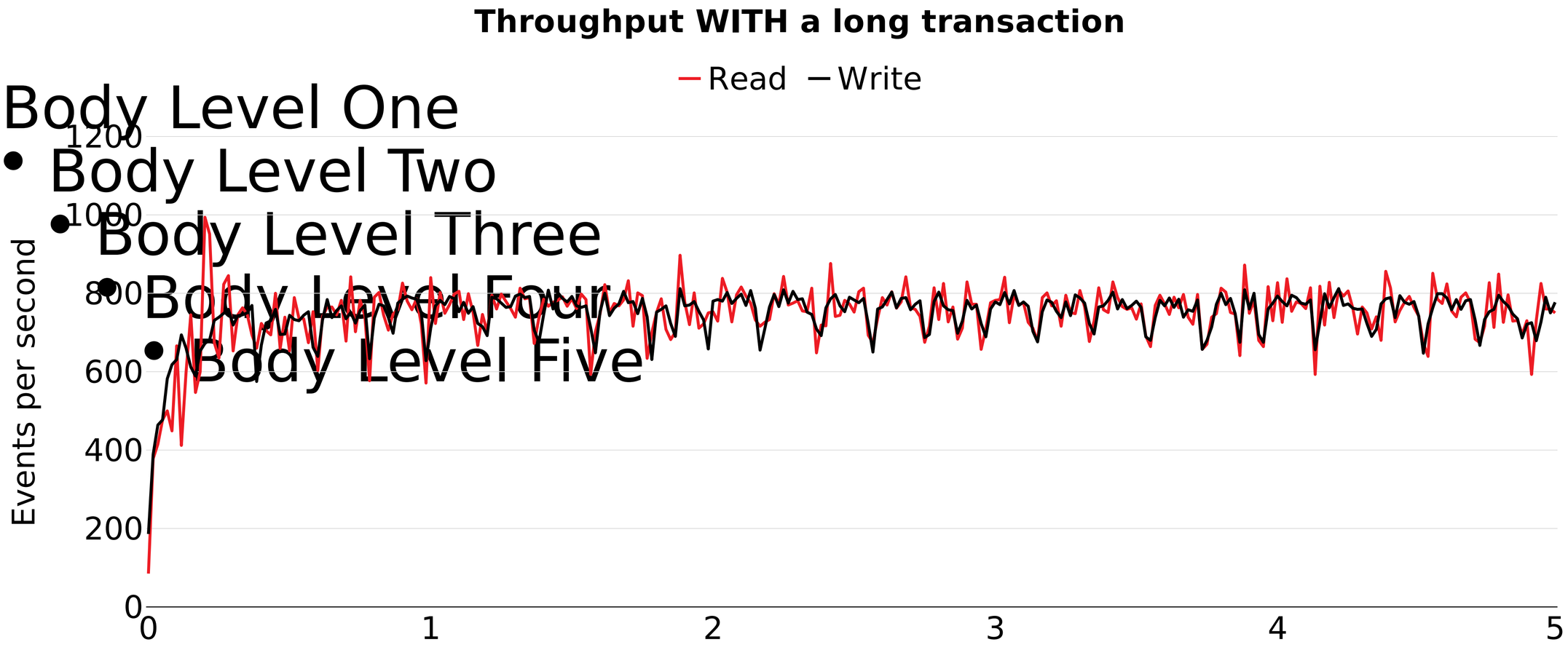

05

Summary

Playground

Toloka / pg-queue-playground

Watch 4 | Fork 0 | Starred 2

Code | Issues | Pull requests | Actions | Projects | Wiki | Security | Insights | Settings

main | 1 branch | 0 tags | Go to file | Add file | Code

Igor Loban Initial commit		2ecc4a8 2 hours ago	1 commit
gradle/wrapper	Initial commit		2 hours ago
pg-configs	Initial commit		2 hours ago
src	Initial commit		2 hours ago
.gitattributes	Initial commit		2 hours ago
.gitignore	Initial commit		2 hours ago

About

Playground for transactional queues in PostgreSQL

- Readme
- View license
- 2 stars
- 4 watching
- 0 forks

Summary

- We found out when transactional queues in DBs are needed
- Transactional Outbox pattern
- PgQ and Eventuate
- Performance tricks
- TRUNCATE against long transactions

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Kindly remind about **metrics**, **alerts**, and **load testing** for your solutions

Titles

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Design patterns

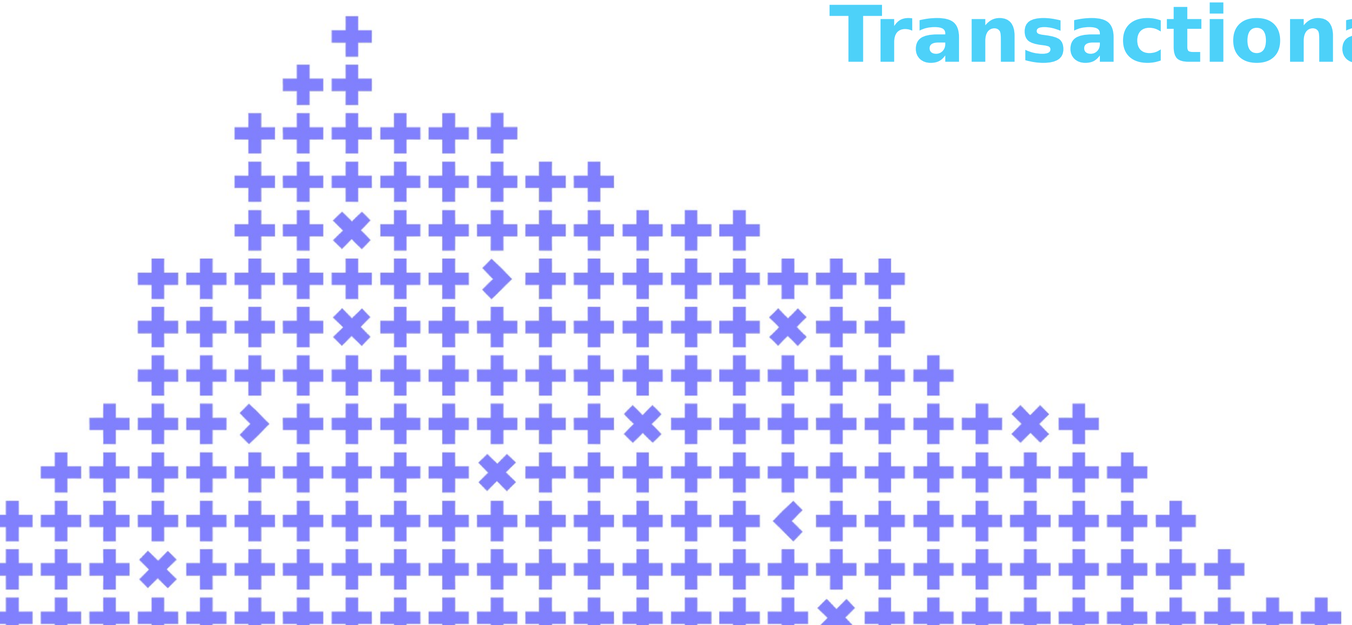
- https://microservices.io/patterns/data/transactional-outbox.html
- https://microservices.io/patterns/data/transaction-log-tailing.html
- https://microservices.io/patterns/data/polling-publisher.html
- https://microservices.io/patterns/data/saga.html

PgQ and Eventuate

- https://www.pgcon.org/2009/schedule/attachments/91_pgq.pdf
- https://habr.com/ru/post/483014/
- https://github.com/eventuate-tram

Leave your feedback!

You can rate the talk and give feedback on what you've liked or what could be improved



Transactional Queues in PostgreSQL

Igor Loban

High Load Armenia

Co-organizer

Yandex